

ID28- SEABED MONITORING WITH GIRONA 500 AUV WORKING AS HROV

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Abstract – This paper presents the use of Girona 500 AUV as a Hybrid ROV (HROV) to inspect underwater habitats by combining basic teleoperation and automatic way-point following. This duality allows safe movements, when inspecting visually the seabed, together with precise way-point movements, when mapping or reaching the area. Also, the use of a HROV containing its own energy simplifies the management of the umbilical cable, which can be smaller, and integrates all safety measures of an AUV. The Girona 500 AUV has been tested acting as HROV during 3 campaigns at 80 metres depth in a project for evaluating the state of transplanted gorgonians.

Keywords – Autonomous Underwater Vehicle, Hybrid Remotely Operated Vehicle, Seabed Monitoring

I. INTRODUCTION

This paper presents a research collaboration to use the Girona 500 AUV [1] (see Fig. 1) for monitoring transplanted gorgonians in the north of Cap de Creus (Spain) at 85 m depth. In the context of the ShelfReCover project [2], gorgonians were transplanted on three artificial lander structures (see Fig. 1), which were deployed on the continental shelf. The AUV Girona 500 was used during 3 campaigns (July 2015, December 2015 and September 2016) to locate the 3 landers, to acquire images of the gorgonians and to map visually and acoustically the area in which the landers were deployed.

Girona 500 was acting as a Hybrid Remotely Operated Vehicle (HROV), being physically connected to a surface boat with an Ethernet connection, but having its own batteries to power all systems, and its software architecture for controlling the robot. The surface boat was also carrying an USBL positioning system, which estimated the position of the vehicle and sent position updates to it (see Fig.2). The HROV was able to follow the commands from the surface boat while transmitting real-time images. Commands varied from simple teleoperation set-points, to high-level commands such as: keep depth, keep altitude, keep heading, keep position, go to waypoint, execute coverage trajectory. The HROV was also running all basic AUV systems, such as the navigation filter and the safety behaviours to avoid minimum altitude and maximum depth, and to abort the mission and emerge in case of failure, such as a loss of communication due to a cut in the umbilical cable.



Figure 1. Girona 500 HROV before the seabed monitoring (left). Image of a lander after 6 months of deployment in Cap de Creus at 85 m depth, with transplanted gorgonians next to natural ones (right).



Fig 2. Girona 500 HROV ready for the experiment on top of a 7 meters boat having the USBL positioning system and the electrical winch for the umbilical communications (top). The HROV has a light 30 meter umbilical cable, which allows a free movement of the vehicle, connected to a vertical 200 meter metallic cable which is provided by the winch. The boat maintains its position on top of the HROV by using the estimates of the USBL.

II. RESULTS

The Girona 500 AUV was equipped with a HD stereo camera system, 2 led lights, a scanning imaging sonar, a multibeam profiler and the umbilical cable, together with the standard equipment: USBL positioning and modem, DVL, IMU, pressure sensor, GPS, sound velocity sensor and 5 thrusters (for surge, sway, heave and yaw degrees of freedom). The 230 meters of umbilical were passing a DSL connection encoding the standard Ethernet network of the AUV, from which all the sensors can be monitored and all levels of control can be managed. During the 3 campaigns of the ShelfReCover project, the HROV was manually teleoperated as a ROV, but also automatically guided as an AUV, all the time with the human supervision. This combination allowed an easy search of the 3 landers, by using the imaging sonar, a teleoperated inspection of the gorgonians (see Fig.3), and some automated movements once the environment was known: keeping altitude, heading or position; travelling from point to point; and way-point following for covering the area (see Fig.4).

The Girona 500 AUV allowed the supervision of the transplanted gorgonian in the 3 landers during the 15 months between their release and the third campaign, showing a very good survival rate of the specie (see Fig. 5). The approach was successful and opened the door to future developments to improve the performance of the HROV concept.

Fig 5. Images of the landers at different moments of the project (from top left to down right): releasing day; after 1 month; after 6 months, after 15 months. It can be appreciated the survivancy of the transplanted gorgonian and, also, the evolution of the marine growth.



Fig 3. Images of the 3 landers in the second campaign, in December 2015.

III. CONCLUSIONS

The three campaigns carried out at more than 80 meters in the waters of Cap de Creus showed the feasibility and advantages of using Girona 500 AUV, a hovering vehicle, as an HROV. Its autonomous behaviours combined with the human supervision and teleoperation, offered a very effective and powerful combination to explore the seabed for scientific purposes. Automatic movements are better when a precise trajectory is desired, while manual movements are better when image interpretation is required.

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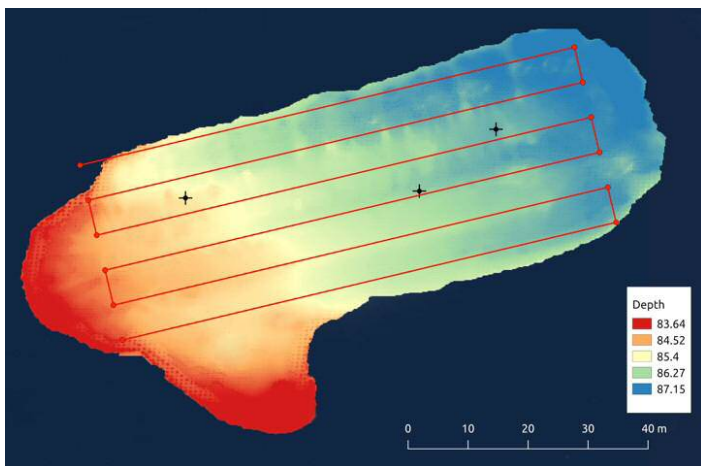


Fig 4. Coverage trajectory for creating the bathymetry of the area including the 3 landers. It can be appreciated the slope of the seabed. Also, the white rectangle shows the point-cloud of one lander (seen laterally) detected by the multibeam.



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